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ARMY ENGINEER WATERWAYS EXPERIMENT STATION VICKSBURG--ETC F/G 20/4
H6125 - SPECIFIC ENERGY AND SPECIFIC FORCE IN A CIRCULAR OPEN C--ETC (L
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ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM H6125 - Specific Energy and Specific Force in a Circular Open Channel		PROGRAM NO. 722-F3-RO-CAK
PREPARING AGENCY Hydraulic Analysis Division, Hydraulics Laboratory, U. S. Army Engineer Waterways Experiment Station, P. O. Box 631, Vicksburg, MS 39180		
AUTHOR(S) Martin T./Hebler	DATE PROGRAM COMPLETED Nov 73 Documented June 78	STATUS OF PROGRAM PHASE Origin STAGE Operational

A. PURPOSE OF PROGRAM

To compute the specific energy and specific force in a circular open channel.
Reference: Chow, Ven Te, Open Channel Hydraulics, McGraw-Hill, 1959, pp 41,54.

LEVEL 12

B. PROGRAM SPECIFICATIONS

SEE FOLLOWING PAGE

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C. METHODS

The program is written in G635 time-share series, FORTRAN IV, and is part of a Conversationally Oriented Real-Time Program-Generating System (CORPS). It consists of a main program and a subroutine. All I/O requirements are handled in the main program with the subroutine handling the computation.

D. EQUIPMENT DETAILS

The program was developed and is operational on WES G635, Vicksburg, MS. It is also operational on the HIS 66/80, Macon, GA, and Boeing CDC, Seattle, WA.

E. INPUT-OUTPUT

The required inputs which are entered at execute time are: discharge cfs, diameter ft, number of flow depths, and flow depths, ft. The output includes the given data, plus the specific energy and specific force.

F. ADDITIONAL REMARKS

Complete documentation of this program is available from the Engineer Computer Programs Library, Technical Information Center, WES.

DISTRIBUTION STATEMENT A
Approved for public release;
Distribution unlimited

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PREVIOUS EDITIONS ARE OBSOLETE.

B. PROGRAM SPECIFICATIONS:Language: ANSI FORTRAN (FORTRAN IV)Solution Requirements: The run command

RUN WEGLIB/CORPS/H6125, R

plus the input variables defined in (E).

Method of Analysis: Solves algebraic equations for the specific energy and specific force.Core Requirements G635: 10 K wordsExternal Storage: NoneRestrictions: Velocity distribution is uniform across the flow section and the invert slope is small (i.e., < 10 degrees).General Equations:

$$\text{Specific Energy } E \text{ (ft of water)} \quad E = y + \frac{Q^2}{2gA^2}$$

$$\text{Specific Force } F \text{ (ft}^3 \text{ of water)} \quad F = A\bar{y} + \frac{Q^2}{gA}$$

where: Q is the discharge (cfs), g is acceleration of gravity (32.2 ft/sec²), y is flow depth (ft), A is cross-section area (ft²) and \bar{y} is the distance (ft) of the centroid of the area A below the surface of flow.

Range of Quantities: Unlimited for practical application.Accuracy: Governed by accuracy of input data; the specific energy and specific force are printed to +0.01 ft and ft³.

REF: ER 1110-1-10 - ENGINEERING AND DESIGN - Engineering Computer
Program Library Standards and Documentation, Appendix B \

PART I: ENGINEERING DESCRIPTION

1. PROGRAM NUMBER: 722-F3-RO-6AK
2. TITLE: H6125 - Specific Energy and Specific Force in a Circular Open Channel.
3. REVISION LOG: N/A
4. PURPOSE OF PROGRAM: To compute the specific energy and specific force in a circular open channel.

Reference:

Chow, Ven Te, Open Channel Hydraulics, McGraw-Hill, 1959, pp 41,54.

5. STEP SOLUTION:

- a. The inputs, discharge (Q) cfs, diameter (D) ft, and flow depth (y) ft, are entered.
- b. The computational steps are:

- (1) Area (A) ft²

$$A = \frac{2y - D}{2} (yD - y^2)^{1/2} + \frac{D^2}{4} \cos^{-1} \left(\frac{D - 2y}{D} \right)$$

- (2) Moment ($A\bar{y}$) ft³ of area with respect to the surface

$$A\bar{y} = \left(\frac{y^2}{3} - \frac{yD}{3} + \frac{D^2}{4} \right) (yD - y^2)^{1/2} + \left(\frac{yD^2}{4} - \frac{D^3}{8} \right) \cos^{-1} \left(\frac{D - 2y}{D} \right)$$

- (3) Specific Energy (E) ft of water

$$E = y + \frac{Q^2}{2gA^2}$$

where g is acceleration of gravity (32.2 ft/sec²)

(4) Specific Force (F) ft³ of water

$$F = A\bar{y} + \frac{Q^2}{gA}$$

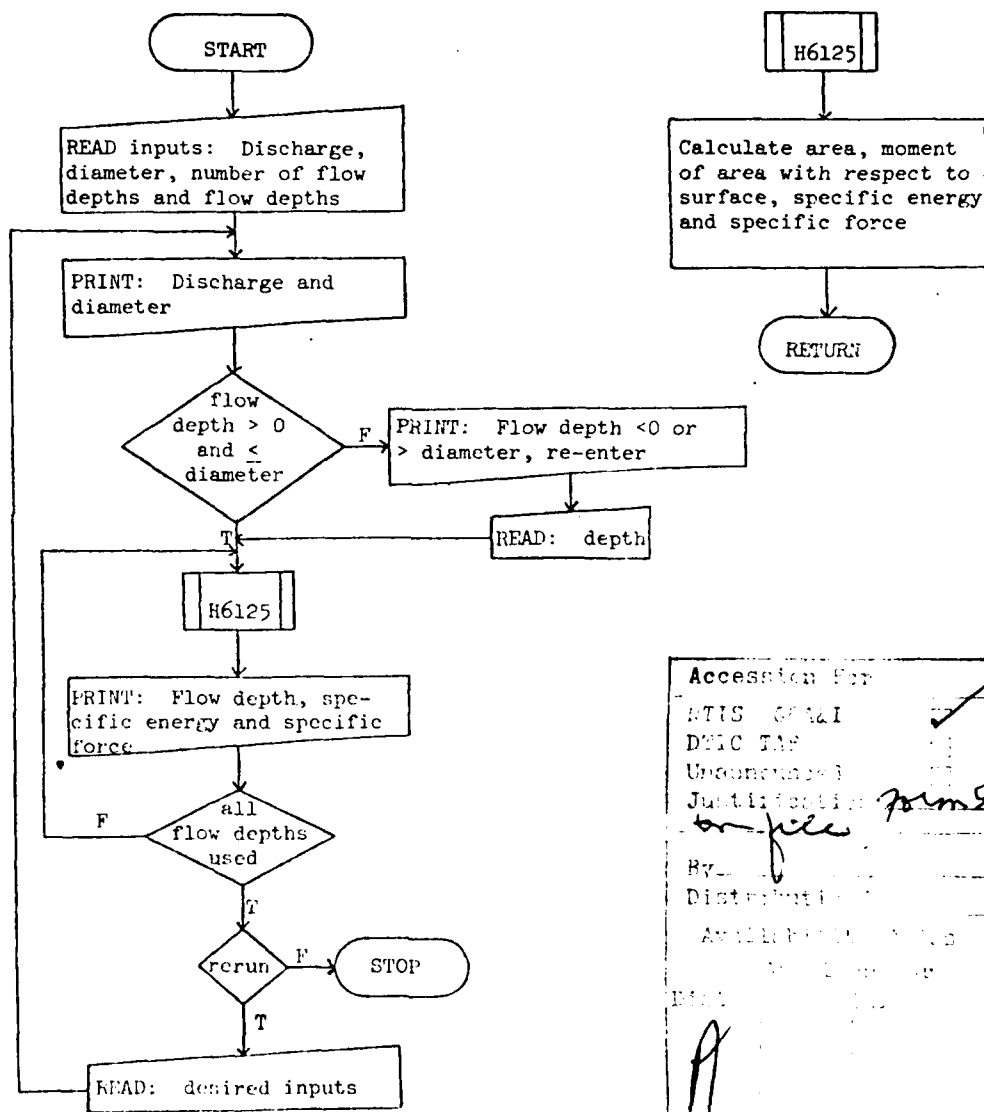
c. The given inputs, plus the specific energy and specific force are printed.

6. ACCURACY: Governed by input data; the specific energy and specific force are printed to the nearest hundredth of a foot and hundredth cubic foot.

7. REMARKS: Velocity distribution is uniform across the flow section and the invert slope is small (i.e., < 10 degrees).

PART II: COMPUTER FUNCTIONAL DESCRIPTION

1. REVISION LOG: N/A
2. FUNCTIONAL FLOW CHART:



3. EQUIPMENT AND OPERATING SYSTEM: The program was developed on a G635 time-share system in which input/output equipment consisted of a Model 33 remote teletype. It is now operational on the WES G635, Vicksburg, MS; HIS 66/80, Macon, GA; and Boeing CDC, Seattle, WA.
4. INPUT REQUIREMENTS: The required inputs are entered via the user's time-share terminal device in free field format. All input cues and reads are performed in the main program. The subroutine handles the computation. Since computations are done in subroutine H6125, the necessary inputs to the subroutine are passed via the CALL statement. The calling sequence is:

```
CALL H6125 (arg1,...,arg5)
```

where:

- arg₁ - discharge, cfs
- arg₂ - diameter, ft
- arg₃ - flow depth, ft
- arg₄ - specific energy, ft of water
- arg₅ - specific force, ft³ of water

All arguments are floating point. Arguments 1-3 are the required inputs and arguments 4 and 5 are the outputs.

5. SECONDARY STORAGE INPUT FORMAT: None
6. INPUT DATA DESCRIPTION: The following names are used for the input variables in program H6125.

DISCH - discharge, cfs (arg₁)

DIAMTR - diameter, ft (arg₂)

N - number of flow depths, integer

Y - flow depth, ft (arg₃)

7. OUTPUT DATA DESCRIPTION: The following names are used for the output variables in program H6125.

ENERGY - specific energy, ft of water (arg₄)

FORCE - specific force, ft³ of water (arg₅)

8. PROGRAM ERROR MESSAGES: If flow depth ≤ 0 or $>$ diameter is detected in the main program, then the message

FLOW DEPTH OF 12.00 FT ≤ 0 or $>$ DIAMETER. RE-ENTER

is printed.

9. VARIABLE DEFINITION:

A - area of flow cross section, ft²

AY - moment of A with respect to surface, ft³

N - number of flow depths, $0 < N \leq 25$

Y - flow depth, ft; dimensioned max 25

DEPTH - flow depth, ft; equal to Y(I), for $I = 1, \dots, N$

DIAMTR - diameter, ft

DISCH - discharge, cfs

ENERGY - specific energy, ft of water

FORCE - specific force, ft³ of water

G - acceleration of gravity, 32.2 ft/sec²

HFILE - five character name of program; passed to WESLIB count routine HACCT

LQZ - equal 1, execute all input cues and reads; equal 2, call
 WESLIB routine RERUN and enter only desired inputs

LQX - equal 1, print instructions from RERUN; equal 3, no print

JKL - direct return from RERUN to desired input read

KKK - total number of inputs; passed to RERUN

WK1 - working storage, one-half top width, ft

WK2 - working storage, ft

WK3 - working storage

ZZZZZ - character, equal RE, rerun program; equal ST, stop

10. EXAMPLE CASE: Compute the specific energy and specific force for
6 given flow depths.

a. Input data:

Discharge (DISCH) = 100.00 cfs

Diameter (DIAMTR) = 5.00 ft

Number of flow depths (N) = 6

Flow depths (Y(I), for I = 1, N) = 1.00, 1.43, 2.50, 4.00, 4.50,
and 5.00 ft

b. Output:

INPUT H6125-SPECIFIC ENERGY AND SPECIFIC FORCE IN A CIRCULAR OPEN
CHANNEL

AA-ENTER DISCHARGE,CFS.

=100

AB-ENTER DIAMETER,FT.

=5

AC-ENTER THE NUMBER OF DEPTH(S) FOR WHICH SPECIFIC ENERGY AND FORCE ARE
TO BE CALCULATED. MUST NOT EXCEED 25 DEPTHS.

=6

AD-ENTER THE 6 DEPTH(S) SEPARATED BY COMMAS.

=1,1.43,2.5,4,4.5,5

OUTPUT H6125-SPECIFIC ENERGY AND SPECIFIC FORCE IN A CIRCULAR OPEN
CHANNEL

DISCHARGE = 100.00 CFS

DIAMETER = 5.00 FT

FLOW DEPTH (FT)	SPECIFIC ENERGY (FT)	SPECIFIC FORCE (FT**3)
1.00	20.87	112.23
1.43	8.66	69.72
2.50	4.11	42.05
4.00	4.55	49.03
4.50	4.95	56.16
5.00	5.40	64.90

ENTER RERUN OR STOP

=STOP

REF: ER 1110-1-10 - ENGINEERING AND DESIGN - Engineering and Computer
Program Library Standards and Documentation, Appendix C

PART III: FILE DOCUMENTATION

1. REVISION LOG: N/A
2. TITLE: H6125 - Specific Energy and Specific Force in a Circular
Open Channel
3. SOURCE PROGRAM LISTINGS: See pages 9-11
4. NUMERICAL AND LOGICAL ANALYSIS: No special numerical techniques
used.
5. SUBROUTINES NOT DOCUMENTED IN ABSTRACT: None
6. MISCELLANEOUS: The program is part of the CORPS computer system.
CORPS is an acronym standing for Conversationally Oriented Real-Time
Program-Generating System. The program is now operational on the WES
G635, Vicksburg, MS; HIS 66/80, Macon, GA; and Boeing CDC, Seattle, WA.
The source listing on page 9 contains the first line run command and
brief for H6125. This first line run command runs the binary H6125B of
the source listing on pages 10-11 (Fortran source of H6125) and attaches
the WESLIB routine HACCT and RERUN.

H6125

0001*#RUN WESLIB/CORPS/H6125B,R;WESLIB/RERUN,R;WESLIB/HACCT,R
0800 61THIS PROGRAM COMPUTES SPECIFIC ENERGY AND SPECIFIC FORCE IN A
0805 23 CIRCULAR OPEN CHANNEL.
0810 36VELOCITY DISTRUBUTION COEF. = UNITY.
0815 56INPUTS REQUIRED ARE DISCHARGE-CFS, DIAMETER-FT, AND FLOW
0820 09DEPTH-FT.
0825 51OUTPUT INCLUDES THE GIVEN DATA AND SPECIFIC ENERGY
0830 19AND SPECIFIC FORCE.
0999*06FINISH

```

00001**RUN *:=:/CORPS/H6125B(NOGO)
10000 CHARACTER*5 HFILE
10010 DIMENSION Y(25)
10020 HFILE=5HH6125
10030 LQZ=1;LQX=1
10040 15000 CALL HACCT(HFILE)
10050 PRINT 15111
10060 15111 FORMAT(/"INPUT  H6125-SPECIFIC ENERGY AND SPECIFIC FORCE IN
10070& A CIRCULAR OPEN"/14X,"CHANNEL"/)
10080 GO TO(15003,15016),LQZ
10090 15003 PRINT 15004
10100 15004 FORMAT("AA-ENTER DISCHARGE,CFS.")
10110 15005 READ,DISCH
10120 GO TO(15007,15016),LQZ
10130 15007 PRINT,"AB-ENTER DIAMETER,FT."
10140 15008 READ,DIAMTR
10150 GO TO(15010,15016),LQZ
10160 15010 PRINT 15121
10165 15121 FORMAT("AC-ENTER THE NUMBER OF DEPTH(S) FOR WHICH SPECIFIC E
10167&NERGY AND FORCE ARE"/"TO BE CALCULATED. MUST NOT EXCEED 25 DEPTHS.
10169&")
10170 15011 READ,N
10180 GO TO(15013,15016),LQZ
10170 15013 PRINT 15113,N
10195 15113 FORMAT("AD-ENTER THE ",I2," DEPTH(S) SEPARATED BY COMMAS.")
10200 15014 READ,(Y(I),I=1,N)
10210 GO TO(15019,15016),LQZ
10220 15016 KKK=4
10230 CALL RERUN(KKK,LQX,JKL)
10240 GO TO(15005,15008,15011,15014,15019),JKL
10250 15019 PRINT 15020,DISCH,DIAMTR
10260 15020 FORMAT(/"OUTPUT  H6125-SPECIFIC ENERGY AND SPECIFIC FORCE IN
10270& A CIRCULAR OPEN"/15X,"CHANNEL"/"DISCHARGE = ",F12.2," CFS"/"
10275&DIAMETER =
10280& ",F13.2," FT"/4X,"FLOW",4X,"SPECIFIC",3X,"SPECIFIC"/4X,"DEPTH",4
10290&X,"ENERGY",5X,"FORCE"/4X,"(FT)",6X,"(FT)",5X,"(FT**3)")
10310 DO 15027 I=1,N
10320 DEPTH=Y(I)
10330 CALL H6125(DISCH,DIAMTR,DEPTH,ENERGY,FORCE)
10340 PRINT 15028,DEPTH,ENERGY,FORCE
10350 15027 CONTINUE
10360 15028 FORMAT(F8.2,2F11.2)
10370 PRINT," "
10380 LQZ=2
10390 CHARACTER ZZZZZZ*2
10400 16000 PRINT,"ENTER RERUN OR STOP"
10410 READ 16001, ZZZZZZ
10420 16001 FORMAT(A2)
10430 IF(ZZZZZZ.EQ.2HRE) GO TO 15000
10440 IF(ZZZZZZ.EQ.2HST) GO TO 20000

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H6125

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10450 PRINT,"ERROR *** RETYPE"  
10460 GO TO 16000  
10470 20000 STOP:END  
30000 SUBROUTINE H6125(DISCH,DIAMTR,DEPTH,ENERGY,FORCE)  
30010 G=32.2;WK1=SQRT(DEPTH*DIAMTR-DEPTH**2)  
30020 WK2=2.*DEPTH-DIAMTR;WK3=ARCOS(-WK2/DIAMTR)  
30030 A=WK1*WK2/2.+WK3*DIAMTR**2/4.  
30040 AY=WK1*(DEPTH**2/3.-DEPTH*DIAMTR/3.+DIAMTR**2/4.)*DIAMTR**2*WK2*W  
30050 K3/8.  
30060 ENERGY=DEPTH +DISCH**2/(2.*G*A**2)  
30070 FORCE=AY+DISCH**2/(G*A)  
30080 RETURN  
30090 END
```

